HW:

p. 300: 5

p. 301: 17

p. 302: 32, 33

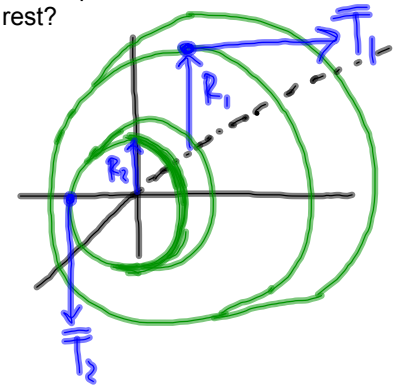
p. 303: 8, 9

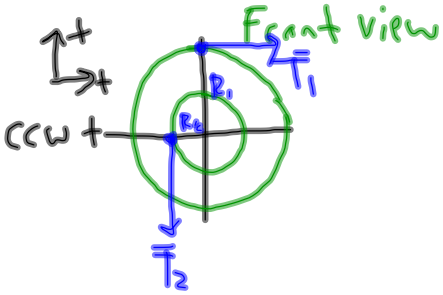
Torque and Static Equilibrium Practice Problems 10.20.11 AP Physics

A one-piece cylinder is shaped as shown in the figure, with a core section protruding from the larger drum. The cylinder is free to rotate around the central axis shown in the figure. A rope wrapped around the drum, which as radius R_1, exerts a force T_1 to the right on the cylinder. A rope wrapped around the core, which has radius R_2, exerts a force T_2 downward on the cylinder.

a) What is the net torque acting on the cylinder about the rotation axis (which is the z-axis)?

b) Suppose T_1 = 5.0 N, R_1 = 1. 0 m, T_2 =15.0 N, and R_2 = 0.50 m. What is the net torque about the rotation axis, and which way does the cylinder rotate starting from rest?





$\bar{R}_1 = R_1 @ 90°$
$\bar{T}_1 = T_1 @ 0°$
$\Theta_1 = -90° \Rightarrow \sin(-90°) = -1$

$\bar{R}_2 = R_2 @ 180°$
$\bar{T}_2 = T_2 @ 270°$
$\Theta_2 = 90° \Rightarrow \sin(-90°) = 1$

a) $\bar{\tau}_1 = \bar{R}_1 \times \bar{T}_1 = R_1 T_1 \sin(-90°) = -R_1 T_1$

$\bar{\tau}_2 = \bar{R}_2 \times \bar{T}_2 = R_2 T_2 \sin(90°) = R_2 T_2$

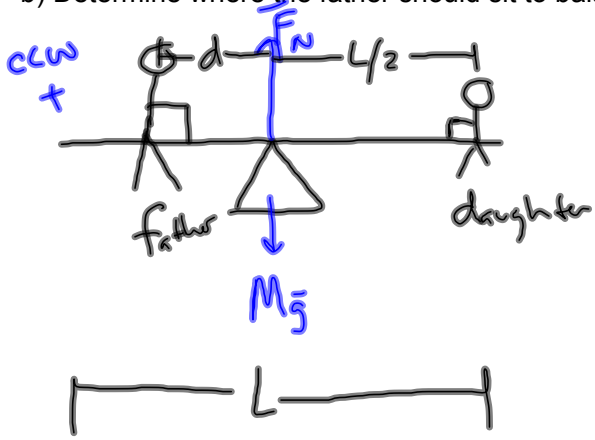
$\Sigma \bar{\tau} = \tau_1 + \tau_2 = -R_1 T + R_2 T_2$

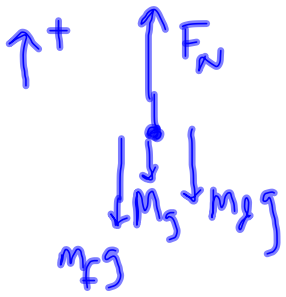
b) $\Sigma \tau = R_2 T_2 - R_1 T_1$

$= 2.5 \text{ J} \rightarrow$ rotating ccw

Torque and Static Equilibrium Practice Problems 10.20.11 AP Physics

A seesaw consisting of a uniform board of mass M and length L supports at rest a father and daughter with masses m_f and m_d, respectively. The support (called the fulcrum) is under the center of gravity of the board, and the father is a distance d from the center, and the daughter is a distance L/2 from the center.
a) Determine the magnitude of the upward normal force exerted by the support on the board.
b) Determine where the father should sit to balance the system at rest.





a) $\Sigma \vec{F} = \emptyset$

$$F_N - m_f g - m_d g - Mg = \emptyset$$

$$F_N = g(m_f + m_d + M)$$

b) $\Sigma \vec{\tau} = \emptyset$

$$r_f F_{wf} - r_d F_{wd} = \emptyset$$

$$d m_f g = \left(\frac{L}{2}\right) m_d g$$

$$d = \left(\frac{L}{2}\right)\left(\frac{m_d}{m_f}\right)$$

$r_f = d$

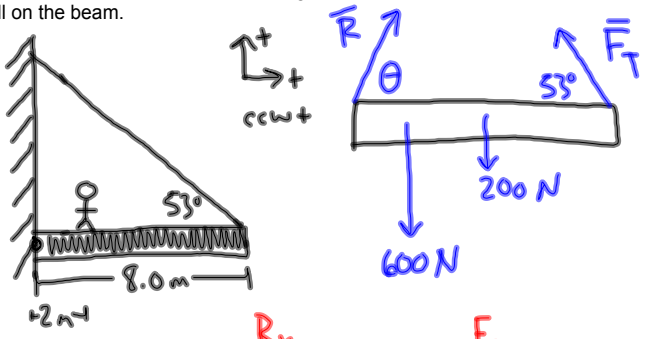
$r_d = L/2$

$F_{wf} = m_f g$

$F_{wd} = m_d g$

Torque and Static Equilibrium Practice Problems 10.20.11 AP Physics

A uniform horizontal beam with a length of 8.00 m and a weight of 200 N is attached to a wall by a pin connection. Its far end is supported by a cable that makes an angle of 53 degrees with the beam. A 600 N person stands 2.00 m from the wall. Find the tension in the cable as well as the magnitude and direction of the force exerted by the wall on the beam.



R_x F_{Tx}

$$\Sigma F_x = R\cos\theta - F_T\cos(53°) = 0$$

R_y F_{Ty}

$$\Sigma F_y = R\sin\theta - 600\,N - 200\,N + F_T\sin(53°) = 0$$

$$R\sin\theta + F_T\sin(53°) - 800\,N = 0$$

$$\Sigma\tau = -r_p F_p - r_b F_b + r_{F_T} F_{Ty} = 0$$

$$-(2\,m)(600\,N) - (4\,m)(200\,N) + (8\,m)F_T\sin(53°) = 0$$

$$F_T = 313\,N$$

$$R\cos\theta - F_T\cos(53°) = 0$$

$$R\cos\theta = F_T\cos(53°) = 188\,N$$

$$R\sin\theta - 800\,N + F_T\sin(53°) = 0$$

$$R\sin\theta = 800\,N - F_T\sin(53°) = 550\,N$$

$$\frac{R\cos\theta = 188\,N}{R\sin\theta = 550\,N} \Rightarrow \tan\theta = 2.93$$

$$\theta = \tan^{-1}(2.93)$$

$$= 71.1°$$

$$R\cos(71.1°) = 188\,N$$

$$R = 580\,N$$

A uniform ladder of length L rests against a smooth, vertical wall. The mass of the ladder is m, and the coefficient of static friction between the ladder and the ground is mu_s = 0.40. Find the minimum angle theta_min at which the ladder does not slip.